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13 November 1956

MEMORANDUM FOR: Project Director

THROUGH : Chief, HTAUTOMAT
THROUGH : Chief, Geographic Research *gfb*
SUBJECT : Computational Problems of the Technical Intelligence
Branch of the Photographic Intelligence Division

1. Summary

The Technical Intelligence Branch of the Photographic Intelligence Division is currently faced with the problem of very extensive work in the field of photogrammetric and allied computations. Present demands are more than the Branch can handle. There is a quite considerable back-log of computations to be made. The prospects for the foreseeable future indicate an increasing demand for metrical support, particularly with regard to the new photographic program.

It is recommended that consideration be given to the procurement of a general purpose, medium capacity electronic computer. It is believed that the adoption of this recommendation, with a moderate increase in Technical Intelligence personnel, will provide the Photo Intelligence Division with the increased capability necessary to extract a much more complete measure of intelligence from presently available and anticipated photography.

2. The Problem

(a) The program presently confronting the Photographic Intelligence Division has created a large volume of unusual photography. The mission of the Division is to perform a complete analysis of this photography and to report the results of this analysis.

(b) The task of the Technical Intelligence Branch is to support the other branches of the Division by (1) furnishing sufficient basic mathematical data to permit the photo interpreters to perform the majority of the more routine measurements; and (2) performing the more intricate measurement problems in support of specific requirements from other Branches. In addition, the Technical Intelligence Branch supports other components of the DD/I, as well as the Army, Navy, and Air Force Liaison Units, in the solution of the unusual measurement problems created by the photography.

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3. Facts Bearing in the Problem

The problem involved, concerning the new photography, can be separated into three parts. The first part concerns the basic mathematical data to be furnished to the Branches, and the second concerns the solution to specific, intricate measurement tasks, and the third part involves the mathematical solution required in other types of technical support.

(a) Basic Mathematical Data

Computation of a complete set of basic data, as outlined below, would permit the solution of perhaps 75% of the measurement problems by the photo interpreter, with only occasional additional assistance by the photogrammetrists of the Technical Intelligence Branch.

The actual computations involved in the complete set of basic data are quite extensive. To completely cover the entire range of parameters for each separate camera will require approximately 500,000 equation solutions. Each of the equations must be solved in terms of three or four direct answers, depending upon the particular camera involved. The answers required from the equations are: (1) X-scale, (2) Y-scale, (3) Nadir-point distance, and (4) Z-scale. All cameras will require answers 1, 2 and 3, but the 4th item, Z-scale, will be unnecessary on several of the configurations. The parameters involved can also be listed. These are: (1) flying altitude, (2) camera focal-length, and (3) tilt of the camera. Other influencing factors are unorthodox cameras, earth curvature, light refraction and lens distortion patterns.

It must be stated that the 500,000 figure is a minimum one. This will provide the four required figures (X-scale, Y-scale, Nadir-point distance, and Z-scale) for a sufficient number of points on each separate photo configuration to permit interpolation to intermediate points, by the photo interpreter, without significant error.

For precise use of this basic data, the Technical Intelligence Branch must still perform two additional functions. First, training of the individual interpreter in the use of the tables must be done. Second, the determination of the specific parameters to be used as arguments for entering the tables for a particular photograph must be determined mathematically by solution of a spacial-resection problem and furnished to the interpreter. This second function can be eliminated in a large number of more routine measurement problems where very precise information is not required. In these instances, the interpreter can use the corrected nominal values for altitude, tilt, and focal length.

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The figure of 500,000 must be considered a minimum one from another standpoint. This figure would hold if the calculations were made in a secure area, by cleared personnel. If the computations were performed by a contractor, a much wider range of parameters would have to be used to cover the actual figures being used operationally. The problem could then be handled as an academic computation of theoretical values, rather than as an operational problem, and would thus be covered from a security viewpoint. The estimated number of equations which would be so involved is estimated at about four million.

(b) Specific Measurement Problems

In addition to the quite extensive basic data computations required as outlined above, the Technical Intelligence Branch is also responsible to the Division and other interested components for the solution of specific measurement problems in answer to particular requirements.

(c) Additional Metrical Support

In addition to the computational problems brought about as a result of the extensive current program, the Technical Intelligence Branch must continue its usual support, by metrical photo analysis, of the Division and other components of the Agency. The range of problem types encountered by the Technical Intelligence Branch is quite wide. This is due to the fact that most technical problems, when carefully analysed, become essentially a series of inter-related mathematical problems. It is natural that such technical problems which are concerned with photography should become the work of the Technical Intelligence Branch.

An example is a current high-priority project for the DD/P which requires a working knowledge in many fields such as: camera capability and performance characteristics; camera and component manufacturers and their production capabilities; modification possibilities as well as test and evaluation of photographic systems and; metrical exploitation of the photographic end-product of such systems.

Another example of a metrical photographic problem is the current test and analysis of the MM50 photographic surveying camera and comparator. This evaluation involves a very wide range of techniques, from stellar and terrestrial photography to analysis of the film from these tests to determine instrumental performance as well as possible application of the system to the solution of Agency requirements.

Both examples just given require very lengthy and rigorous mathematical solutions.

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4. Discussion

The facts presented in paragraph 3 serve to indicate the present computational situation of the Technical Intelligence Branch.

It has become quite evident to the Photographic Intelligence Division that some method other than those already being used must be found to improve the analysis, computation, and data handling situation of the Technical Intelligence Branch.

There are several possible solutions to this problem. These are listed in the order of their probable value.

(a) Procurement of Electronic Computing Equipment

Investigation by the Technical Intelligence Branch with the guidance of [] Chief of the Business Machines Service, MGT/S, has disclosed two general purpose engineering and scientific computers which would be quite suitable for handling volume photogrammetric and allied computations. (Further information on the characteristics and capacity of these machines is to be found in the attached memorandum to the AD/RR, dated 1 November 1956, from [] of the Technical Intelligence Branch.) Either of these computers would be adequate for handling all Branch as well as Division computations which are of such a nature as to be economically coded and entered into the machine. Practically all Photographic Intelligence Division computations are of this type. It is believed that many calculations of other components of the Geographic Research Area are also of such a nature and could be handled during slack period of use of the machine.

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(b) Lease, or Service Rental, of Electronic Computers

It is feasible to lease the machine, or arrange by contract for the use of the machine, for the solution of problems as outlined before. However, it must be said that in the long term consideration this appears to be less economical process than outright purchase. Over a period of several years, the lease or service rental fees would quite probably amount to as much as the cost of a general purpose, medium capacity computer. In addition, efficiency in such an operation would suffer, due to the fact that Agency use would have to be scheduled when convenient, rather than when actually needed.

(c) Contracting of Computations with Private Firms

This is a distinct possibility, as at least one firm is currently cleared to handle the numerical data, and also has an electronic

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computer capable of rapid solution and tabulation of the necessary information. A visit was made to this organization, Spica, Inc., in West Somerville, Mass., by members of the Technical Intelligence Branch to determine the feasibility of such an operation. Dr. James C. Baker, president of Spica, and also a member of CIA's Scientific Advisory Board, was consulted regarding a proposal of Spica to furnish generally the same information as required by this Branch. With modification, plus the inclusion of additional refinements, and the increase of the range of parameters, the information would be adaptable as furnished in tabular form. Spica initially asked about \$10,000 and a months time to furnish these data. There would undoubtedly be a substantial increase in the money and time required to incorporate the desired additions. Also, there would be additional work necessary beyond the scope of the initial contract.

The contracting of such work is feasible. However, just this initial contract proposal would cost about one-third to one-fourth of the price of a calculator as described in paragraph 4(a).

(d) Procurement of Additional Technical Intelligence Personnel

The present staff of this Branch is not able to handle even the routine metrical problems imposed by the new photography and the unusual photogrammetric requirements of the Division. Branch responsibilities to other Agency components, as well as the computation of a complete set of basic data, are naturally suffering as a result of this situation. The addition of more Branch personnel is urgently needed, and steps are being taken to overcome this. However, it is of doubtful economics to attempt to hire a sufficient number of photogrammetrists and mathematicians to perform the computations and solve the problems which could be handled by the present Branch staff, plus a reasonable additional increase of personnel, with the use of rapid computation techniques available through electronic computing machines.

5. Conclusion

The Technical Intelligence Branch of the Photographic Intelligence Division is currently faced with the problem of very extensive work in the field of photogrammetric and allied computations. The present demands are more than the Branch can handle. There is a quite considerable back-log of computations to be made. The prospects for the foreseeable future indicate an increasing demand for metrical support, particularly with regard to the new photographic program, but also in the field of the more routine metrical support.

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The recommendation in paragraph 6 is believed to be that most likely to offer an economical and efficient solution to the problem in the near future.

6. Recommendation

It is recommended that consideration be given to the procurement of a general purpose, medium capacity electronic computer. It is believed that the adoption of this recommendation, with a moderate increase in Technical Intelligence personnel, will provide the Photographic Intelligence Division with the increased capability necessary to extract a much more complete measure of intelligence from presently available and anticipated photography.



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Chief, Technical Intelligence Branch

Enclosure:

Memorandum dated 1 November 1956

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